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PATENT APPLICATION

Sir:

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For: SUBSTRATE CUTTING METHOD AND SUBSTRATE CUTTING APPARATUS

Enclosed are:

- ☒ Specification and Claims.
- ☐ Oath or Declaration.
- ☒ Transmittal Letter Under 37 C.F.R. § 1.53 and M.P.E.P. § 601.01.
- ☒ NINETEEN (19) sheets of formal drawings.
- ☐ An assignment of the invention to \_\_\_\_\_
- ☐ Certified copies of \_\_\_\_\_ priority application.
- ☒ An Information Disclosure Statement, PTO-1449 and 1 document is also enclosed.
- ☐ Associate power of attorney.

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SUBSTRATE CUTTING METHOD AND  
SUBSTRATE CUTTING APPARATUS

BACKGROUND OF THE INVENTION

5 Field of the Invention

The invention relates to a substrate cutting method and a substrate cutting apparatus. More particularly, for example, the invention relates to a substrate cutting method and a substrate cutting apparatus which are suitably used for cutting a substrate of a thin film semiconductor device constructed by adjacently arranging *as if in* ~~like~~ a plane a plurality of substrates on each of which thin film semiconductor elements which are two-dimensionally arranged are installed.

15 Related Background Art

A reduction optical system and a CCD type sensor are generally used as a reading system of a facsimile, digital copying apparatus, an X-ray image pickup apparatus, or the like. In recent years, however, owing to the development of a photoelectric converting semiconductor material represented by amorphous silicon hydride (hereinafter, abbreviated to "a-Si"), what is called a one-dimensional or two-dimensional contact type sensor such that photoelectric converting elements and a signal processing unit are formed on a substrate of a large area and an image is read by an optical

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system having the same magnification as that of an information source is progressively being developed. Particularly, since a-Si can be used as not only a photoelectric converting material but also a thin film electric field effect type transistor (hereinafter, abbreviated to "TFT"), a-Si has an advantage such that a photoelectric converting semiconductor layer and a semiconductor layer of the TFT can be simultaneously formed.

As an example of a photoelectric converting apparatus having such a contact type sensor, we have proposed an apparatus disclosed in the Official Gazette of European Patent Publication Laid-Open No. 0660421.

Fig. 1 is a schematic overall circuit diagram showing an example of the foregoing photoelectric converting apparatus. Fig. 2A is a schematic plan view for explaining an example of an element which is used as each component element corresponding to one pixel of the above photoelectric converting apparatus. Fig. 2B is a schematic cross-sectional view taken along the line 2B-2B in Fig. 2A.

In Fig. 1, S11 to S33 denote photoelectric converting elements. One electrode side of such an element (for example, a lower electrode side) is shown by G and another electrode side (for example, an upper electrode side) is shown by D. C11 to C33 denote capacitors for accumulation; T11 to T33 TFTs for

transfer; Vs a power source for reading out; and Vg a power source for refreshing. The power sources Vs and Vg are respectively connected to the G electrodes of all of the photoelectric converting elements S11 to S33 through switches SWs and SWg. The switch SWs is connected to a refresh control circuit RF through an inverter. The switch SWg is directly connected to the refresh control circuit RF and is controlled so as to be turned on for a refreshing period of time. One pixel is constructed by one photoelectric converting element, a capacitor, and a TFT and its signal output is connected to an integrated circuit IC for detection by a signal wiring SIG.

According to the photoelectric converting apparatus which has been proposed by us before, <sup>a</sup>total <sup>of</sup> nine pixels are divided into three blocks and outputs of three pixels per block are simultaneously transferred and are sequentially converted into outputs by the integrated circuit IC for detection through the signal wiring SIG and are generated (Vout). Three pixels in one block are arranged in the lateral direction and three blocks are sequentially vertically arranged, thereby two-dimensionally arranging the pixels.

Although a portion surrounded by a broken line in the diagram is formed on a same insulating substrate of a large area, a schematic plan view of an example of a

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portion corresponding to the first pixel in such a large area portion is shown in Fig. 2A. A schematic cross-sectional view of a portion taken along a broken line 2B-2B in Fig. 2A is shown in Fig. 2B. As for the photoelectric converting element S11, TFT ... T11, and accumulating capacitor C11, the elements are not particularly separated but the capacitor C11 is formed by increasing an area of an electrode of the photoelectric converting element S11. Such a structure can be accomplished because the photoelectric converting element and the capacitor has the same layer construction.

A silicon nitride film SiN for passivation and a fluorescent material ~~CsI~~ such as cesium iodide <sup>CsI</sup> or the like serving as a wavelength converting material are formed in the upper portion of the pixel. In such a structure, when an X-ray enters from the upper position, it is converted into ~~the~~ light (shown by a broken line arrow) by the fluorescent material CsI and the light enters the photoelectric converting element. In the photoelectric converting apparatus, as shown in the diagram, nine pixels are two-dimensionally arranged in a form of 3 x 3. As will be also understood from the diagrams with respect to the driving, an example in which the outputs of the nine pixels are divisionally transferred and generated three times simultaneously every three pixels is shown. Therefore, by

two-dimensionally arranging the pixels as, for example,  
(5 x 5) pixels per millimeter in the vertical and  
lateral directions, an X-ray detector of (40 cm x 40  
cm) is derived. By combining such an X-ray detector to

5 an X-ray generator in place of an X-ray film and  
constructing an X-ray Roentgen apparatus, such an  
apparatus can be used for a nondestructive inspection  
of a structural material or the like, <sup>{such as performing a chest Roentgen}</sup> ~~a chest Roentgen~~ <sup>←</sup>  
medical examination, or <sup>examining for</sup> ~~a~~ cancer of the breast.

10 Different from the film, consequently, an output of  
such an apparatus can be instantaneously displayed by a  
CRT. Further, the output ~~can be~~ <sup>can be</sup> converted into an  
output according to an object by converting the output  
into a digital value and <sup>performing</sup> image processing by a  
15 computer. The output ~~can be~~ <sup>can be</sup> stored onto a  
magneto optic disk and a past image ~~can be~~ <sup>can be</sup> also  
instantaneously retrieved. As for a sensitivity as  
well, a clear image can be obtained by a very weak X-  
ray in which an influence on the human body is less  
20 than that by the film.

Figs. 3 and 4 are schematic plan views showing  
embodiments of a photoelectric converting apparatus  
having (2000 x 2000) pixels as examples. <sup>the</sup> In case of  
constructing (2000 x 2000) detectors, it is sufficient  
25 to increase the number of elements in a region  
surrounded by the broken line shown in Fig. 1 in the  
vertical and lateral directions. In this case,

however, there are 2000 control wirings g1 to g2000 and there are also 2000 signal wirings SIG (sig1 to sig2000). A shift register SR1 and the integrated circuit IC for detection also have to execute 2000 control processes, so that a scale of the apparatus is large.

In a photoelectric converting apparatus of a large area in which the substrate area increases and the number of elements which are formed increases, it is difficult to perfectly eliminate micro dust upon manufacturing, particularly, <sup>debris</sup> ~~trash~~ which is peeled off from a wall of a thin film depositing apparatus when an amorphous silicon layer is deposited onto the substrate and dust remaining on the substrate when a metal layer is deposited onto the substrate. There is, consequently, a case where it is not easy to eliminate an inconvenience of the wirings, namely, a short-circuit or an open state of the wirings.

When the control wiring or signal wiring of the photoelectric converting apparatus <sup>is</sup> ~~are~~ short-circuited or opened, there is a case where output signals of all of the photoelectric converting elements connected to such a wiring are inaccurate. In such a case, the apparatus cannot be actually used as a photoelectric converting apparatus. Namely, as one sheet of <sup>a</sup> substrate when the photoelectric converting apparatus of a large area is manufactured enlarges in size, a



a  
probability of the occurrence of the short-circuit or open state per substrate rises. Thus, a yield of the substrate decreases with an increase in size of *the* substrate and, at the same time, an amount of loss due to an inconvenience per substrate also increases.

a  
To solve the above problems, a method of constructing a larger effective area by adjacently arranging *as if in* ~~like~~ a plane a plurality of substrates on each of which photoelectric converting elements which are two-dimensionally arranged are installed has been proposed.

A proposed structure will now be described with reference to the drawings.

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In a photoelectric converting apparatus shown in Fig. 5, it is a characteristic point that four photoelectric converting apparatuses 100, 200, 300, and 400 constructed on four substrates are joined *as if in* ~~like~~ a plane (adjacently arranged), thereby constructing one large photoelectric converting apparatus.

a  
a  
A  
For instance, (100 × 100) photoelectric converting elements are arranged on the photoelectric converting apparatus 100 and are connected to *a of* total 2000 wirings of the 1000 control wirings g1 to g1000 and the 1000 signal wirings sig1 to sig1000. The shift register SR1 is formed in one chip every 100 stages. *Ten* ~~Total~~ ten shift registers SR1-1 to SR1-10 are arranged on the substrate 100 and are connected to the control wirings

g1 to g1000.

The integrated circuit for detection is also formed in one chip every 100 processing circuits.

*a*  
*ten*  
~~Total ten~~ integrated circuits IC1 to IC10 are arranged  
5 and are connected to the signal wirings sig1 to sig1000. Even in the photoelectric converting apparatuses 200, 300, and 400, in a manner similar to the photoelectric converting apparatus 100, (100 × 100) photoelectric converting elements are arranged and are  
10 connected to 1000 control wirings by 1000 signal wirings. In addition, ten shift registers and ten integrated circuits for detection are arranged, thereby constructing a large photoelectric converting apparatus.

15 As a method of cutting each substrate of the photoelectric converting apparatuses 100, 200, 300, and 400 so as to obtain design dimensional values, a slice line is formed on the substrate on which the photoelectric converting elements are installed and the  
20 slice line is cut, thereby cutting each substrate.

Ordinarily, a cutting apparatus is constructed by a stage to hold the substrate and a blade as a cutting member. The stage can be moved in the X-axis direction (left/right direction on the paper surface) and can be  
25 rotated. The blade can be moved in the Y-axis direction (upper/lower direction on the paper surface; the rotation of the blade is parallel with the X

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direction). Thus, four sides of the substrate can be cut. Specifically speaking, the blade is moved in the Y-axis direction to the cutting position. The stage is rotated and a rotary axis is fixed in a manner such

5 that the slice line which is used as an alignment mark displayed on the monitor screen through a camera fixed to a blade unit is parallel with the slice direction, namely, <sup>a</sup>stage moving direction. After that, the stage and blade are moved to a cutting start position and the  
10 blade is dropped onto the substrate, thereby starting the cutting operation. The cutting is executed by mechanically moving the stage in the X direction.

After four sides were cut as mentioned above, four substrates are combined and joined <sup>as if in</sup> like a plane onto  
15 the substrate so as to form a gap between the adjacent substrates, thereby forming the photoelectric converting apparatus of a large area.

According to the photoelectric converting apparatus with the above construction, by improving a  
20 yield per substrate upon manufacturing, costs of the substrate are reduced, so that the costs of the photoelectric converting apparatus of a large area or in which a plurality of substrates are combined can be reduced.

25 However, in the foregoing photoelectric converting apparatus of a large area constructed by joining <sup>as if in</sup> like a plane a plurality of substrates on each of which the

photoelectric converting elements which are two-  
dimensionally arranged are installed, when the cut  
substrates are arranged, the gap between the substrates  
is not constant, so that there is a subject to be  
5 improved such that there is a case where an image  
quality of the gap portion of the photoelectric  
converting apparatus of the large area deteriorates.

Fig. 6A is a schematic plan view showing a  
positional misalignment or a bending of the cut line at  
10 the time of such a substrate cutting. Reference  
numeral 101 denotes a slice line and 103 indicates a  
photoelectric converting portion of a unit of one  
substrate. As shown in Fig. 6A, a state in which a  
positional misalignment or a bending of the cut line  
15 occurs due to a position matching or parallel ejection  
misalignment or a precision of the apparatus is  
illustrated.

Fig. 6B is a diagram clearly showing a variation  
in gaps between the substrates in the case where four  
20 substrates (photoelectric converting portions) 103 each  
having a cutting position misalignment or a bending of  
the cut line as mentioned above are arranged on a base  
plate 105. As shown in Fig. 6B, there is a case where  
a gap occurs between the adjacent substrates upon  
25 joining due to a misalignment, a bending, or a warp of  
the cut surface. Although the conventional apparatus  
obviously does not have such a large misalignment or

a  
bending, it is a fact that there is also a case where a  
problem occurs from a viewpoint of a size of <sup>a</sup>pixel.

#### SUMMARY OF THE INVENTION

5           It is an object of the invention to provide a  
substrate cutting method and a substrate cutting  
apparatus which can perform an accurate cutting  
operation when a substrate is cut.

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10           Another object of the invention is to provide a  
substrate cutting method and a substrate cutting  
apparatus in which when a plurality of substrates are  
arranged, the substrates can be adhered by making a gap  
between the substrates constant or reducing or  
eliminating such a gap.

15           Still another object of the invention is to  
provide a substrate cutting method and a substrate  
cutting apparatus which can improve an image quality in  
a gap portion between substrates.

a  
20           <sup>yet</sup>~~Further~~ another object of the invention is to  
provide a substrate cutting method of detecting a  
position of a guide line provided in correspondence to  
a slice line and cutting a substrate along the slice  
line while correcting a cutting position.

a  
25           <sup>yet</sup>~~Further~~ another object of the invention is to  
provide a substrate cutting method whereby when a  
substrate on which a slice line and a guide line are  
formed is cut along the slice line of the substrate, a

misalignment is detected by detecting the guide line upon cutting and the substrate is cut while correcting the misalignment.

*a*  
*get*  
Further another object of the invention is to  
5 provide a substrate cutting apparatus comprising: a cutting mechanism; a unit for relatively moving a cutting position of the cutting mechanism for an object to be cut; a unit for detecting a position at a position different from the cutting position; and a  
10 unit for adjusting the cutting position on the basis of position information *obtained* by the position detecting unit.

*get*  
Further another object of the invention is to  
provide a substrate cutting apparatus for cutting a substrate formed with a slice line for cutting the  
15 substrate and a guide line for detecting a misalignment upon cutting, comprising: a unit for cutting the slice line; a unit for detecting the misalignment by detecting the guide line upon cutting; and a unit for correcting a misalignment quantity when the  
20 misalignment occurs during the cutting.

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BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic circuit constructional diagram in a whole photoelectric converting apparatus;

25 Fig. 2A is a schematic plan view of one pixel of a photoelectric converting element;

*a*  
Fig. 2B is a schematic cross-sectional view of one

pixel of the photoelectric converting element;

Figs. 3, 4, and 5 are schematic plan views each for explaining an example of a photoelectric converting apparatus;

5 Fig. 6A is a schematic plan view for explaining an example of a cutting of a substrate;

Fig. 6B is a schematic plan view for explaining an example of an arrangement of cut substrates;

10 Fig. 7 is a flowchart for explaining an example of a cutting <sup>in</sup> of the invention;

Figs. 8, 10, 12A, 14, 15, 16, 19, and 20 are schematic plan views each for explaining an example of a substrate having a photoelectric converting element of the invention;

15 Figs. 9A, 9B, 12B, and 12C are schematic diagrams each for explaining an example of an alignment method;

Figs. 11, 13A, and 13B are schematic side elevational views each for explaining an example of a cutting apparatus;

20 Fig. 17 is a schematic plan view showing an example of a base plate (stage) on which a member to be cut is mounted;

a Fig. 18 is a schematic cross-sectional view for explaining a cutting state; and

25 Fig. 21 is a block constructional diagram of an example of a substrate cutting apparatus.

# DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

According to a substrate cutting method of the invention, a substrate is cut along a slice line, a guide line corresponding to the slice line is formed, a cutting position is detected by the guide line, and the cutting position is corrected.

A substrate cutting apparatus of the invention has a cutting unit and a unit for correcting a cutting position by the cutting unit on the basis of position information detected by a position detecting unit.

The foregoing objects of the invention can be accomplished by the above substrate cutting method and apparatus.

More specifically [speaking], side surfaces of the adjacent substrates can be accurately cut and the substrates can be arranged (adhered) *as if in* like a plane while eliminating or reducing a gap between the adjacent substrates. ← \*\*

The invention will now be described hereinbelow with reference to the drawings as necessary.

(Embodiment 1)

A preferred example of the cutting method of the invention will be described further with reference to the drawings in accordance with a processing flow of Fig. 7.

Fig. 8 is a diagram showing the slice line 101 and a guide line 102 provided on the substrate surface.

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The slice line 101 and guide line 102 are formed by an electrode layer simultaneously formed in parallel with a first or second electrode constructing a TFT or a sensor or by the first or second electrode. Therefore, they can be formed by the same material.

Figs. 9A and 9B are diagrams when the substrate is set onto a stage 204 (refer to Fig. 11) of the cutting apparatus and the slice line 101 is displayed on a monitor 201 through a CCD camera set in the cutting apparatus. Fig. 9A shows a state in which an alignment is not perfect. In such a case, by moving or rotating the position of the stage 204, the slice line 101 is matched with a scale line 104 on the monitor 201. Fig. 9B shows a state in which the alignment is performed.

Fig. 10 is a plan view of a substrate showing an example of an alignment order. To improve a matching precision and a working efficiency, a matching process is executed from a substrate center portion 1 on the slice line 101 and the alignment position is moved (for example, in accordance with the order of 2 → 3 → 4 → 5), thereby gradually matching the position with the direction of an edge portion of the substrate.

After completion of the matching process, a cutting operation is started. Fig. 11 is a schematic side elevational view for explaining a preferred example of the cutting apparatus. As shown in Fig. 11, a light is irradiated from a light source 203 to the

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guide line 102. The light is reflected by the guide line 102, thereby confirming the cutting position by a detecting sensor 205. The light source 203 is provided as necessary and an external light can be also used according to circumstances.

For example, when a misalignment of the stage 204 occurs in an A direction in the diagram, a sensor output of ~~1-2~~<sup>sensor portion (2)</sup> decreases and a sensor output of ~~1-1~~<sup>sensor portion (1)</sup> rises. Therefore, a misalignment movement quantity of the stage 204 is calculated from a difference between those outputs and the stage 204 is moved in a B direction and is returned to the original position.

When a misalignment of the stage 204 occurs in the B direction, the sensor output of ~~1-2~~<sup>sensor portion (2)</sup> decreases and a sensor output of ~~1-3~~<sup>sensor portion (3)</sup> rises, so that a misalignment movement quantity of the stage 204 is calculated from a difference between those outputs and the stage 204 is moved in the B direction and is returned to the original position.

As described above, while the slice line 101 is being cut, the light reflected from the guide line 102 is monitored by the detecting sensor 205.

After the two slice lines 101 on the substrate ~~were~~<sup>are</sup> cut, a spindle (blade) 202 is elevated and moved to a position on the guide line 102 and starts to cut the guide line 102. In this instance, the detecting sensor 205 does not perform the detection and operation

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20293  
A  
A  
(although a precision<sup>in cutting</sup> of the cutting surface is required to <sup>{where a substrate is joined to another}</sup> join to the other substrate on the slice line side, on the guide line side, since <sup>the substrate does</sup> it is not come into contact with the other substrate, a cutting precision is not required as compared with <sup>that of</sup> the slice line side). It is not always necessary to cut the guide line in accordance with a situation such as a size of <sup>the</sup> substrate or the like.

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After the cutting of the guide line <sup>is</sup> finished, the spindle (blade) 202 is elevated and the stage 204 is rotated by 90°. After the stage 204 <sup>is</sup> rotated by 90°, the spindle 202 executes a matching process from the substrate center portion 1 on the second slice line. When seeing the alignment position shown in Fig. 10 as an example, the alignment position is moved in accordance with the order of 2 → 3 → 4 → 5, thereby gradually matching the position with the direction of the substrate edge portion in a manner similar to <sup>that</sup> the above.

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After completion of the matching, the cutting operation is started. While the light reflected from the second guide line is detected by the detecting sensor, the second slice line is cut. After the second slice line <sup>is</sup> cut, the spindle is moved to the position on the second guide line and starts to cut the second guide line. After completion of the cutting of the second guide line, the cutting operation is

finished.

(Embodiment 2)

*a*  
The guide line ~~can be~~ <sup>can be</sup> also commonly used as a slice line. In such a case, the following processing  
5 steps are executed.

Fig. 12A shows a line in which the slice line and guide line formed on the substrate surface are shared (combined).

A common line 106 is formed by an electrode layer  
10 formed in parallel with a first or second electrode constructing a TFT or a sensor together with such an electrode or by the first or second electrode.

Figs. 12B and 12C schematically show examples in the case where the substrate is set onto the stage of  
15 the cutting apparatus and the common line is displayed on the monitor through the CCD camera installed in the cutting line. When the alignment is not performed as shown in Fig. 12B, by moving or rotating the stage position, the front edge portion of the common line  
20 portion is matched with the scale line on the monitor so as to be aligned as shown in Fig. 12C.

After completion of the matching process, the cutting operation is started. At the same time, as shown in schematic side elevational views of Figs. 13A  
25 and 13B, a light is irradiated to the common line from the light source 203 provided in front of the spindle.

*as a 4*  
The light is reflected by the <sup>{common line 106, which is a}</sup> guide line, thereby

{←}

*124*

confirming the cutting position by the detecting sensor. Fig. 13B is a diagram when Fig. 13A is seen from the right side in the diagram.

For example, when a misalignment of the stage occurs in the A direction, a sensor output of <sup>sensor portion (2)</sup> ~~A 2~~ decreases and a sensor output of <sup>sensor portion (1)</sup> ~~A 1~~ rises. Therefore, a misalignment movement quantity of the stage is calculated from a difference between those outputs and the stage is moved in the B direction and is returned to the original position.

When a misalignment of the stage occurs in the B direction, the sensor output of <sup>sensor portion (2)</sup> ~~A 2~~ decreases and a sensor output of <sup>sensor portion (3)</sup> ~~A 3~~ rises. Therefore, a misalignment movement quantity of the stage is calculated from a difference between those outputs and the stage is moved in the B direction and is returned to the original position.

As described above, while the <sup>first</sup> common line ~~A 1~~ <sup>106</sup> is being cut, the light reflected from the <sup>first</sup> common line ~~A 1~~ <sup>106</sup> is monitored by the detecting sensor.

After completion of the cutting of the <sup>first</sup> common line ~~A 1~~ <sup>106</sup>, the spindle is elevated and moved to the front edge position on a <sup>second</sup> common line ~~A 2~~ <sup>106</sup> and starts to cut the <sup>second</sup> common line ~~A 2~~ <sup>106</sup>. In a manner similar to the cutting of the <sup>first</sup> common line ~~A 1~~ <sup>106</sup>, during the cutting operation, the light reflected from the <sup>second</sup> common line ~~A 2~~ <sup>106</sup> is monitored by the detecting sensor.

After completion of the cutting of the <sup>second</sup> common line ~~2~~, the spindle is elevated and the stage is rotated by 90°.

After the stage was rotated by 90°, the spindle moves, and a <sup>third</sup> common line ~~3~~ is displayed on the monitor through the CCD camera. By moving and rotating the stage position, the front edge portion of the <sup>third</sup> common line ~~3~~ is matched with the scale line on the monitor. In a manner similar to the case of cutting the <sup>first</sup> common line ~~1~~, during the cutting operation, the light reflected from the <sup>third</sup> common line ~~3~~ is monitored by the detecting sensor.

After completion of the cutting of the <sup>third</sup> common line ~~3~~, the spindle is elevated and moved to the front edge position on a <sup>fourth</sup> common line ~~4~~ and starts to cut the <sup>fourth</sup> common line ~~4~~. In a manner similar to the case of cutting the <sup>first</sup> common line ~~1~~, during the cutting operation, the light reflected from the common line ~~4~~ is monitored by the detecting sensor.

(Embodiment 3)

In the embodiment, a cutting method of a sensor array substrate in the case where a sensor array is formed in a region of (215 mm × 215 mm) on a glass substrate of (300 mm × 250 mm) will now be described.

Fig. 14 shows a schematic plan view of the sensor array substrate. In the diagram, reference numeral 301 denotes a pixel region and a region of one pixel has

dimensions of 160  $\mu\text{m}$   $\times$  160  $\mu\text{m}$ . Reference numeral 302 denotes a wiring leading portion; 303 a slice line which is commonly used as a guide line; and 305 an unnecessary portion. An enlarged diagram of an A  
5 portion in Fig. 14 is shown in Fig. 15. Reference numerals 304A and 304B denote monitor lines for confirming a cutting precision. A width of each line is set to 7  $\mu\text{m}$ .

The monitor line in the embodiment is used to  
10 finally confirm the cutting at a high precision. The monitor line ~~can be~~ <sup>can be</sup> also used to detect an abnormality of the cutting apparatus. In the embodiment, the monitor lines are provided on both sides of the slice line as shown in Fig. 15. A monitor line 304A inside  
15 the slice line, namely, on the pixel side is a limit line toward the inside provided in consideration of a misalignment quantity and a chipping quantity upon cutting. In other words, it is a limit margin from a pixel at which an influence on the pixel  
20 characteristics begins. The embodiment shows a case where the margin is set to 25  $\mu\text{m}$ . The cutting of the limit line denotes an occurrence of an abnormality of the apparatus or a deterioration of the blade (rotary blade) which is used upon cutting. In such a case, it  
25 is necessary to promptly take a countermeasure. On the other hand, a monitor line 304B outside of the slice line denotes a maximum misalignment quantity when

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inside  
monitor  
line.

considering a case where four substrates are joined in order to realize a large area. That is, when the substrate is cut in excess of the monitor line 304B, namely, when this line remains, there is a case where a gap between the adjacent substrates upon joining four substrates cannot satisfy a design value. In such a case, an apparatus abnormality is also similarly considered. As shown in Fig. 16, the gap between the adjacent substrates after four substrates <sup>are</sup> were joined in the embodiment can be set to 320  $\mu$ m in which one pixel is omitted from the pixel center of the corner portion of each substrate.

In the embodiment, in order to more vertically cut the cutting surface, a stage 310 in which a groove ~~notch~~ 312 having a depth of 1 mm is formed in accordance with the slice line is used. Fig. 17 shows a schematic plan view and Fig. 18 shows a cross sectional view taken along the line 18-18 in Fig. 17 (the blade is not shown in Fig. 17). A blade 311 is designed so as to perfectly cut a substrate 313 and enter the ~~stage~~ groove ~~portion~~ 312. No problem occurs when a projection tooth amount of the blade projecting under the substrate is set to a value within a range from 0.3 mm to 0.5 mm. In the embodiment, it is set to 0.5 mm.

The substrate is set onto the foregoing stage, the stage is moved while seeing the slice line on the

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white  
monitor  
line

←

1

2



monitor screen through the CCD camera installed in the cutting apparatus, and the front edge portion of the slice line is matched with the scale line on the monitor screen.

5           After completion of the matching process, the cutting operation is started. Simultaneously, the light is irradiated to the slice line from a light source arranged in front of the spindle. The light is reflected by the slice line, the cutting position is confirmed by the detecting sensor, the slice line is cut while correcting the slice misalignment quantity.

10           After the slice line <sup>is</sup> ~~was~~ cut, the spindle is elevated and moved to the front edge position on a next slice line and starts to cut the slice line. In a manner similar to the slice line, during the cutting operation, the light reflected from the monitor line is monitored by the detecting sensor. After the cutting of the slice line serving as a common line <sup>is</sup> ~~was~~ finished, the spindle is elevated and the stage is rotated by 90°. After that, the remaining two slice lines are similarly cut.

15           After all of the slice lines <sup>are</sup> ~~were~~ cut or, in particular, after the slice line in the substrate joining portion <sup>is</sup> ~~was~~ cut, the presence or absence of the monitor line is confirmed. Ordinarily, the inside monitor line, namely, on the pixel side remains and the outside monitor line does not remain because it has

been cut. By joining a plurality of, for example, four sensor array substrates cut in this manner, a large area and a low price can be realized.

a  
a  
5 In the embodiment, although the guide line is commonly used as a slice line, <sup>also</sup> the monitor line can be ~~also~~ obviously commonly used as a guide line.

(Embodiment 4)

The embodiment will now be described with respect to a cutting confirming method in case of electrically  
10 checking the monitor line used in the embodiment 3.

a  
Specifically speaking, as shown in Fig. 19, the inside monitor line 304A, namely, on the pixel side, is connected and wired up to a wiring leading portion, a pad portion (not shown) is provided, and after the  
15 cutting, whether it is open or not is confirmed by a tester. Since an electrical confirmation is performed, there is an advantage such that an evaluation can be performed in a short time.

(Embodiment 5)

20 The embodiment will now be described with respect to an example of a monitor line in which the embodiment 4 is further improved.

Specifically speaking, as shown in Fig. 20, a  
monitor line outside the slice line and a monitor line  
25 on the pixel side are connected. Each line is wired up to a wiring leading portion, a pad portion (not shown) is provided, and after the cutting, whether it is open

or not is confirmed by a tester. As a confirming method, first, an open state of A-B, a short-circuit of A-C, and a short-circuit of B-D are confirmed by the tester. There is also likewise an advantage such that since the electrical confirmation is performed, an evaluation of a slice misalignment to the outside and inside, an apparatus abnormality, a deterioration of the blade, or the like can be easily performed.

As shown in the diagram, there is obviously no need to limit the portion connecting the inside and outside monitor lines to only the edge portions of the monitor lines but they ~~can be~~ <sup>can be</sup> also connected in an intermediate region. By connecting the monitor lines in the intermediate region, a cutting misalignment in only portions other than both edge portions can be more easily found out.

The substrate cutting apparatus of the invention can be constructed as shown in, for example, a schematic block constructional diagram of Fig. 21.

In the diagram, information from a position detecting unit 2101 is inputted to a control unit 2102. The control unit 2102 calculates a present cutting position and generates to a moving unit 2105 an instruction for relatively moving a cutting unit 2104 such as <sup>a</sup> rotary blade, water jet nozzle, or the like for the substrate as an object to be cut as necessary. The moving unit 2105 can have <sup>an</sup> arbitrary structure and form

so long as it can move at a necessary precision. For example, the moving unit can have a driving unit such as <sup>a</sup>linear motor, piezoelectric vibrator, or the like and, as necessary, a power transfer unit such as <sup>a</sup>screw-shaped member, gear, chain, or the like. As a cutting mechanism 2103, an example having the cutting unit 2104 and moving unit 2105 is shown and explained in the diagram. In <sup>the</sup> case of moving only the stage on which the substrate is mounted, however, it is not always

10 necessary that the cutting unit 2104 constructs a part of the cutting mechanism. The cutting mechanism 2103 ~~can be~~ <sup>can be</sup> also constructed by including a part of the control unit 2105. In any one of the above constructions, the cutting position is detected in

15 accordance with position information 2106 of the guide line and the cutting operation is executed while relatively adjusting the cutting position, so that the cutting operation is executed at a desired high precision.

20 According to the substrate cutting method of the invention as described above, since the side surfaces of the adjacent substrates can be accurately cut, the substrates can be joined <sup>as if in</sup> ~~like~~ a plane by eliminating a gap between the adjacent substrates or reducing the gap

25 so as to be smaller than the current gap. Therefore, ~~an effect such that~~ an image quality of the substrate joining portion of the photoelectric converting

apparatus of a large area can be improved ~~is obtained~~.

According to the invention, a yield per substrate upon manufacturing of the photoelectric converting apparatus of a large area is improved and a loss amount per substrate due to an inconvenience is reduced, so that the costs of the photoelectric converting apparatus of a large area can be reduced.

The present invention is not limited to the foregoing embodiments but many modifications and variations are possible within the spirit and scope of the appended claims of the invention.

When an accuracy of cutting is required, the invention ~~can be~~ <sup>can be</sup> also applied to a cutting of a substrate other than the cutting of the photoelectric converting apparatus <sup>of</sup> ~~like~~ the invention.

WHAT IS CLAIMED IS:

1. A substrate cutting method of detecting a position of a guide line provided in correspondence to a slice line and cutting a substrate along said slice line while correcting a cutting position.

2. A method according to claim 1, wherein said guide line is used as a guide line of said slice line and is, thereafter, set to a slice line for cutting.

3. A method according to claim 1, wherein said guide line is formed simultaneously with said slice line.

4. A method according to claim 1, wherein said guide line is an electrode line provided on the substrate.

5. A method according to claim 1, wherein the detection of said position is executed by using a light source and a photoelectric converting element.

6. A method according to claim 1, wherein said cutting is executed by a rotary blade.

7. A method according to claim 1, wherein said slice line and said guide line are formed by electrode

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layers provided on the substrate.

8. A method according to claim 7, wherein said electrode layer is formed by a same material as that of an electrode line formed on said substrate.

9. A method according to claim 7, wherein said electrode layer is formed simultaneously with an electrode line formed on said substrate.

10. A method according to claim 1, wherein said slice line and said guide line are arranged in parallel.

11. A substrate cutting method whereby when a substrate on which a slice line and a guide line are formed is cut along said slice line of said substrate, a misalignment is detected by detecting said guide line upon said cutting and the substrate is cut while correcting said misalignment.

12. A method according to claim 11, wherein said slice line and said guide line are electrode lines constructing a thin film semiconductor element formed on said substrate.

13. A method according to claim 11, wherein said

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guide line is commonly used as said slice line.

- 5 14. A substrate cutting apparatus comprising:  
a cutting mechanism;  
a unit for relatively moving a cutting position of  
said cutting mechanism for an object to be cut;  
a unit for detecting a position at a position  
different from said cutting position; and  
a unit for adjusting the cutting position on the  
10 basis of position information by said position  
detecting unit.
- 15 15. An apparatus according to claim 14, wherein  
said cutting mechanism has a cutting unit.
- 16 16. An apparatus according to claim 15, wherein  
said cutting unit has a rotary blade or a water jet  
nozzle.
- 20 17. An apparatus according to claim 16, wherein  
said position detecting unit has a photoelectric  
converting apparatus.
- 25 18. A substrate cutting apparatus for cutting a  
substrate on which a slice line for cutting the  
substrate and a guide line for detecting a misalignment  
upon cutting, comprising:



a unit for cutting said slice line;  
a unit for detecting the misalignment by detecting  
said guide line upon said cutting; and  
a unit for correcting a misalignment quantity when  
5 said misalignment occurs during the cutting.

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ABSTRACT OF THE DISCLOSURE

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5 By performing an accurate cutting when a substrate is cut, a gap between the substrates when a plurality of substrates are arranged is made constant or is reduced or eliminated, thereby improving electric characteristics of the gap portion between the substrates. For this purpose, a slice line and a guide line are provided on the substrate, the substrate is cut along the slice line, and the guide line is  
10 detected upon cutting, thereby detecting a misalignment and cutting the substrate while correcting the misalignment.

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FIG. 1

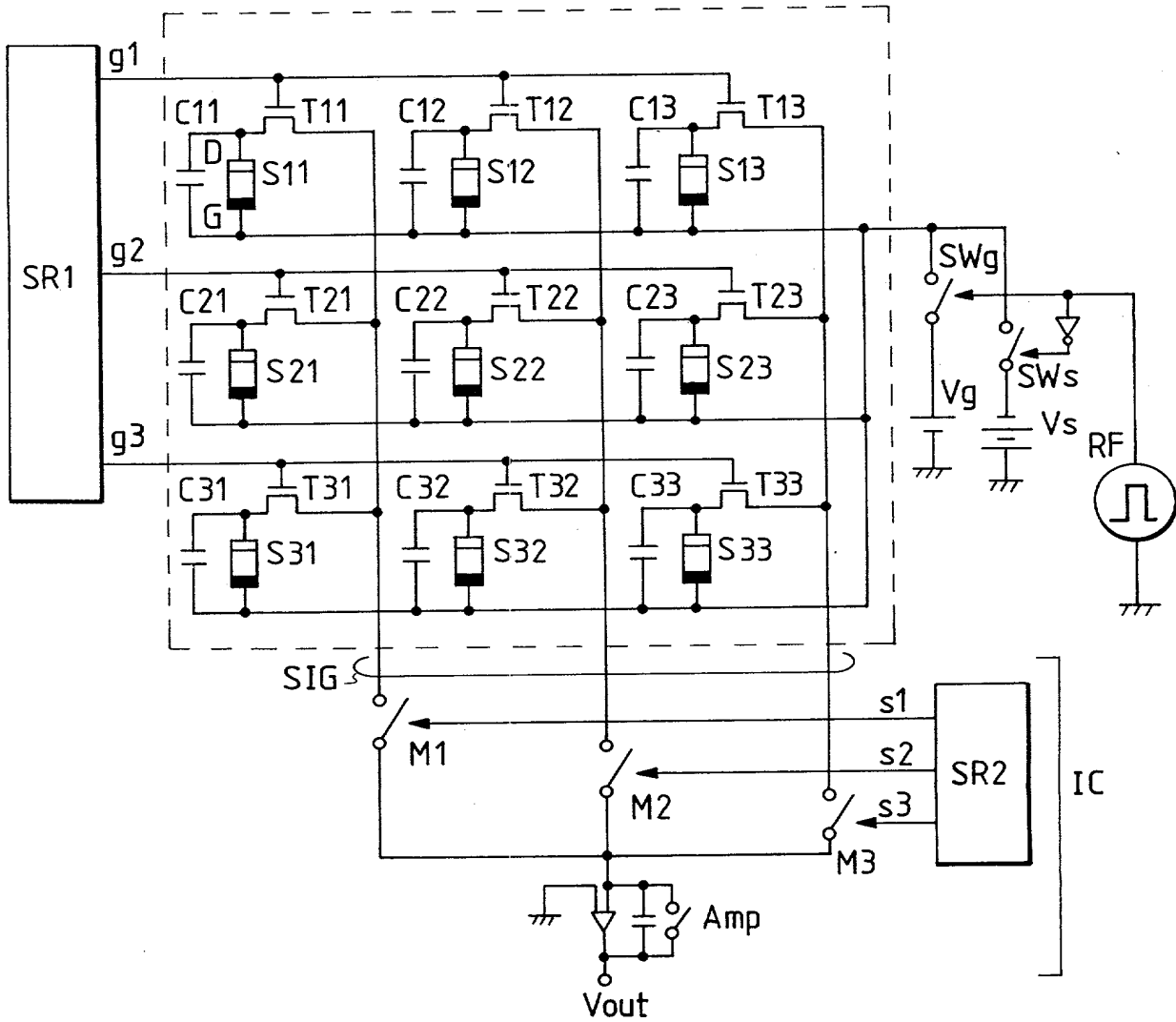


FIG. 2A

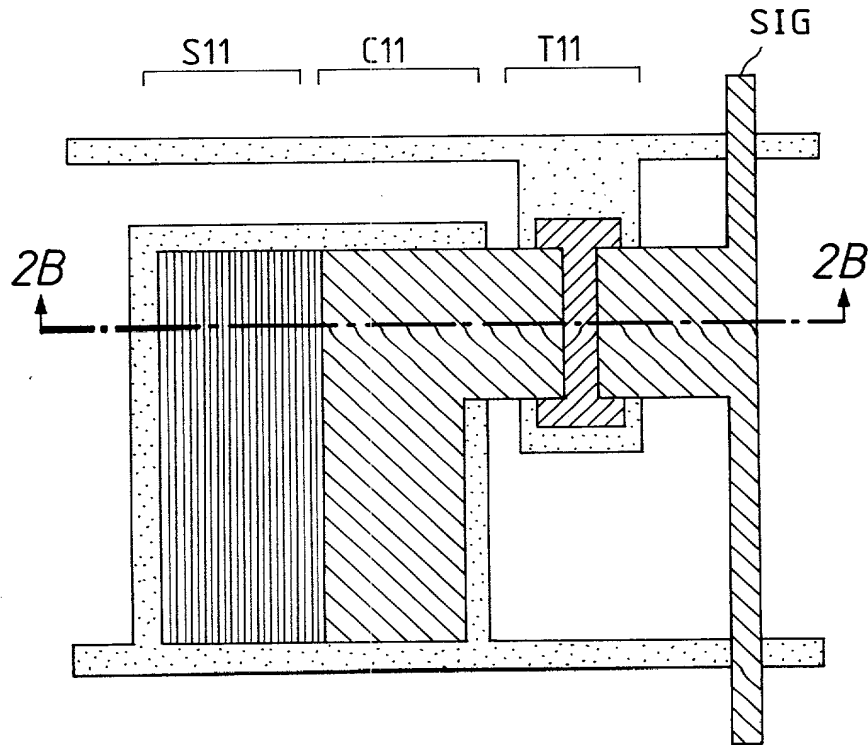
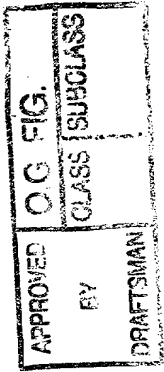
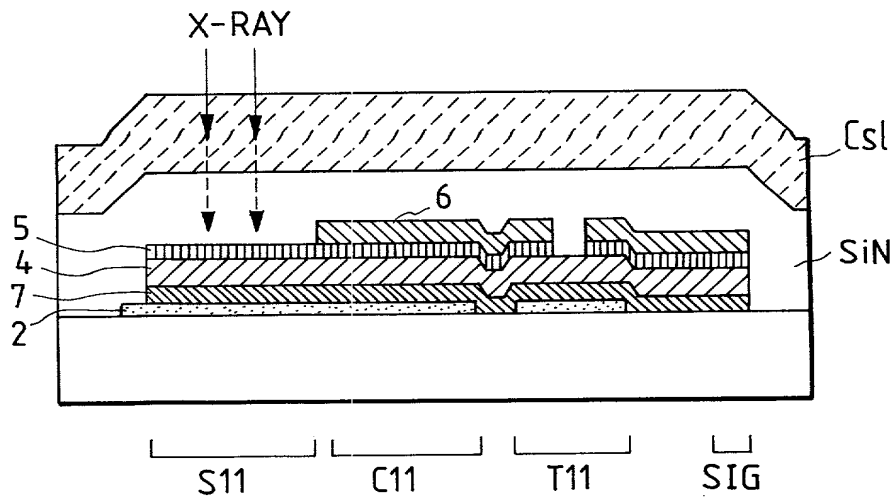


FIG. 2B



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FIG. 3

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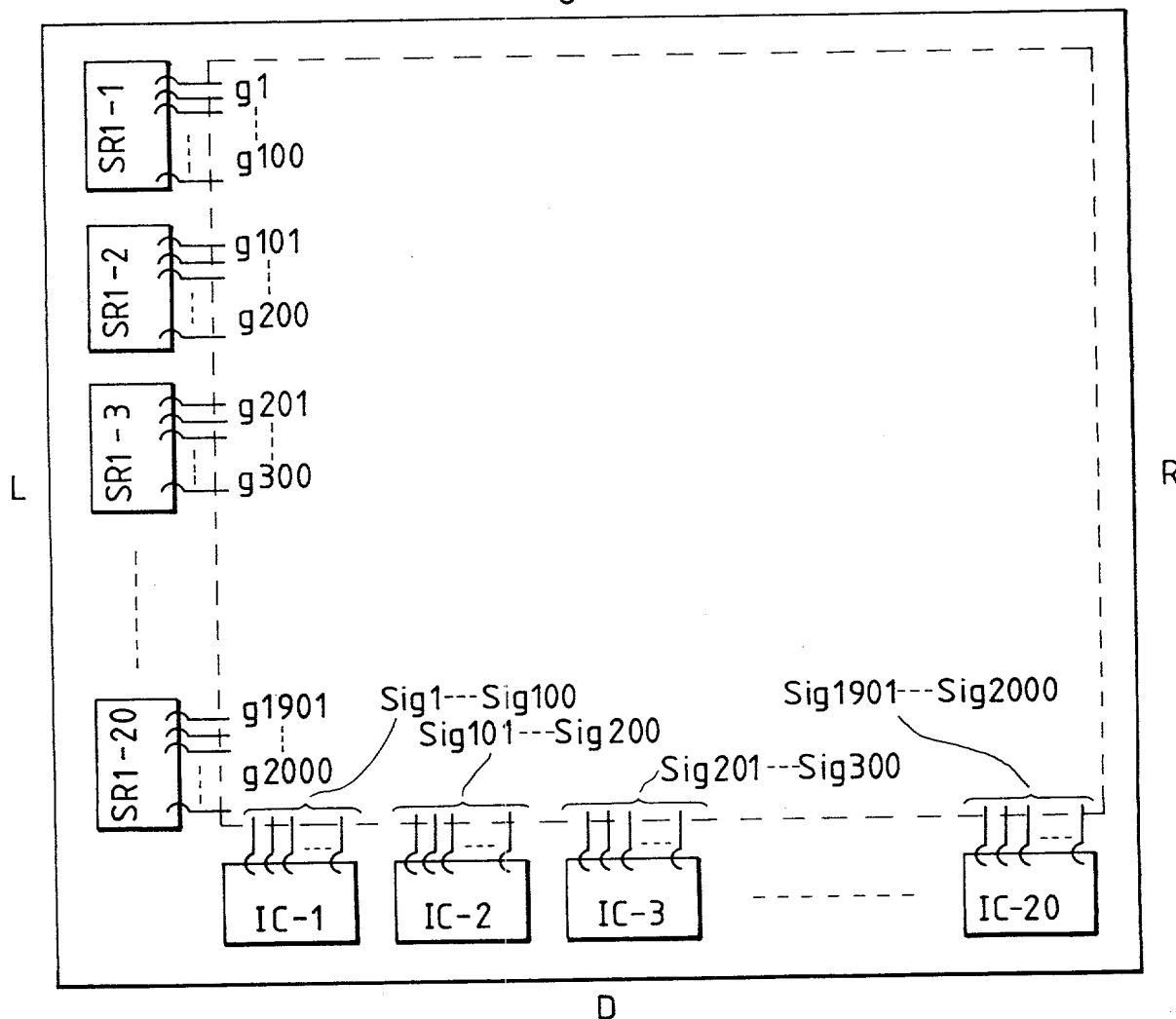
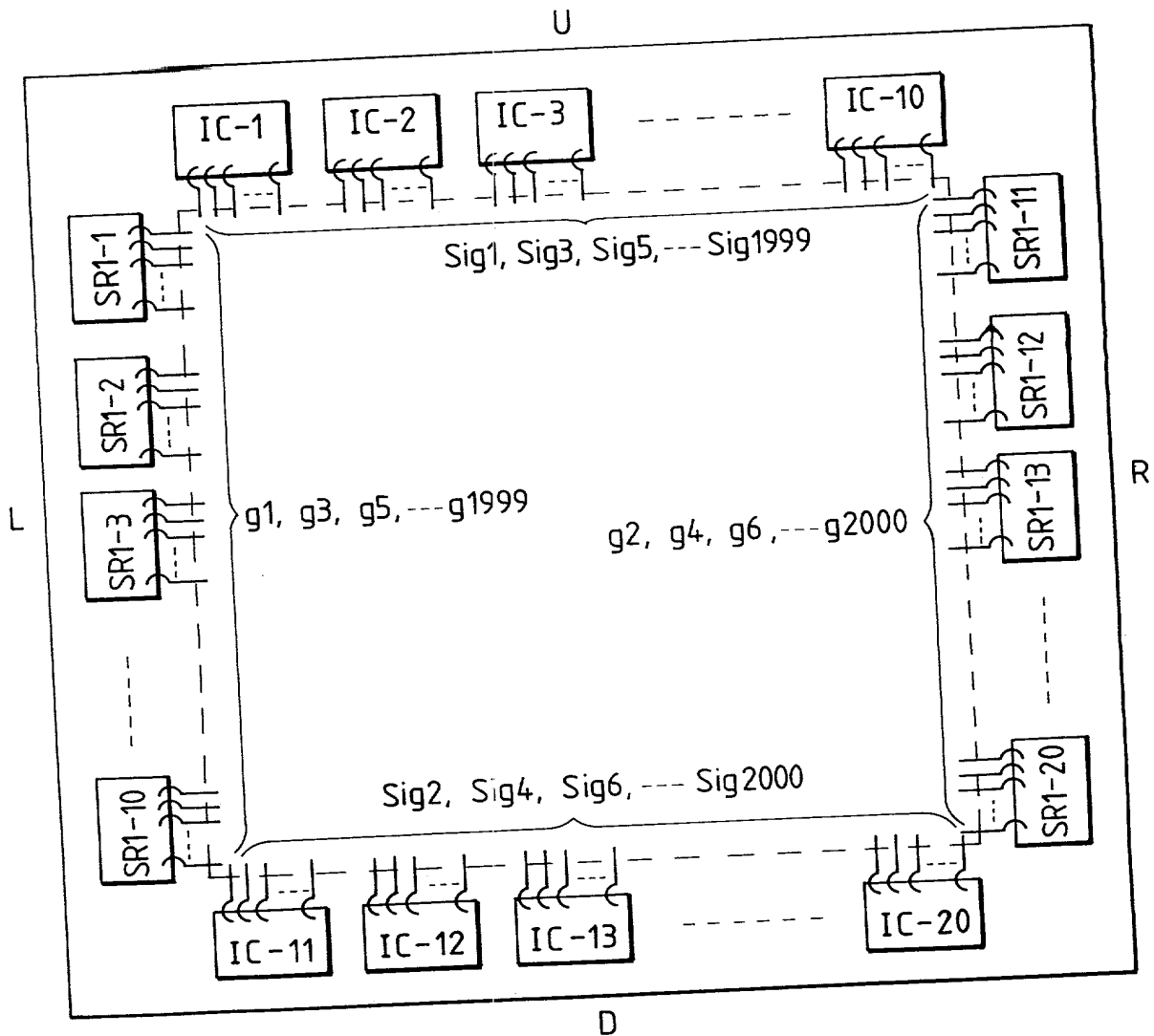


FIG. 4



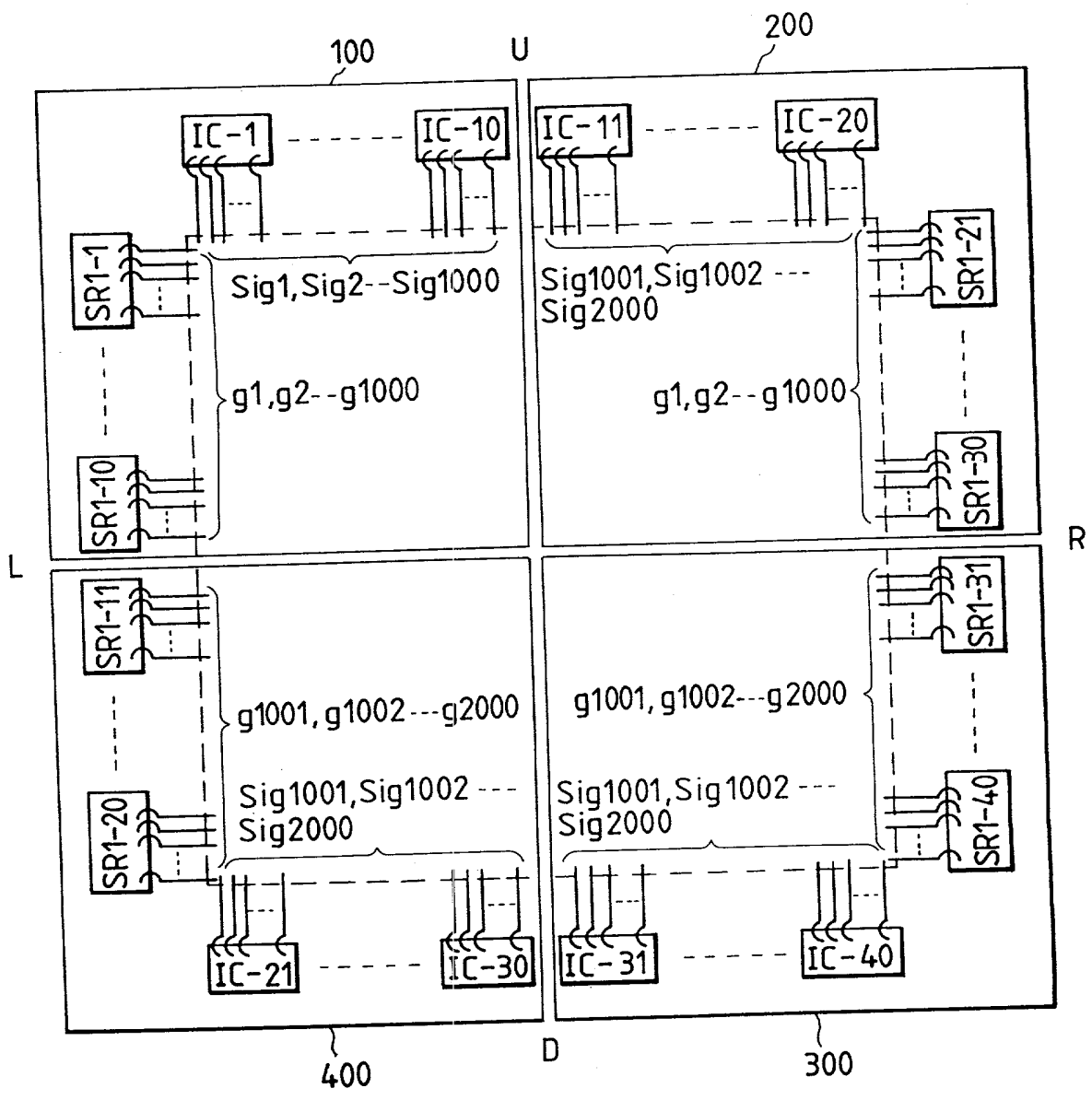
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FIG. 5



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FIG. 6B

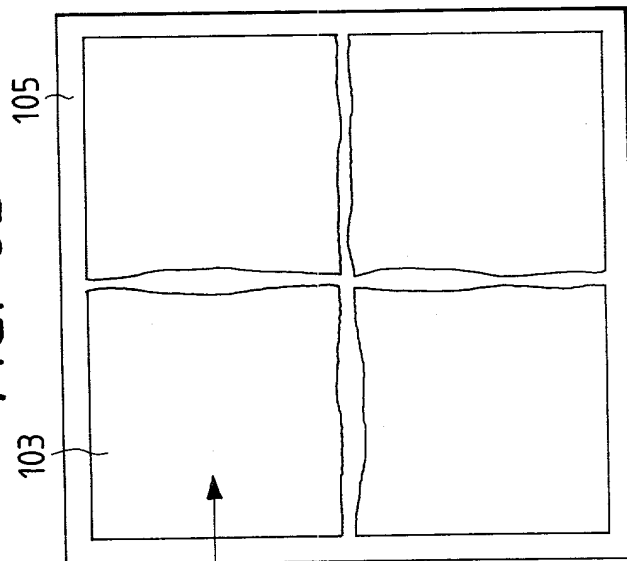
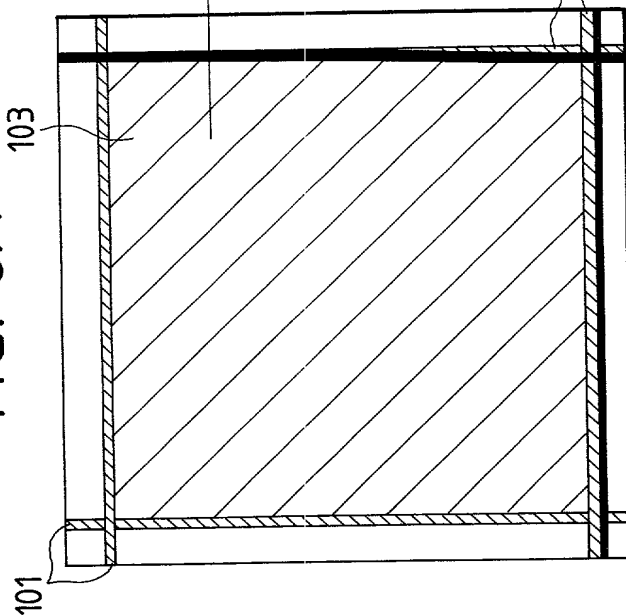


FIG. 6A



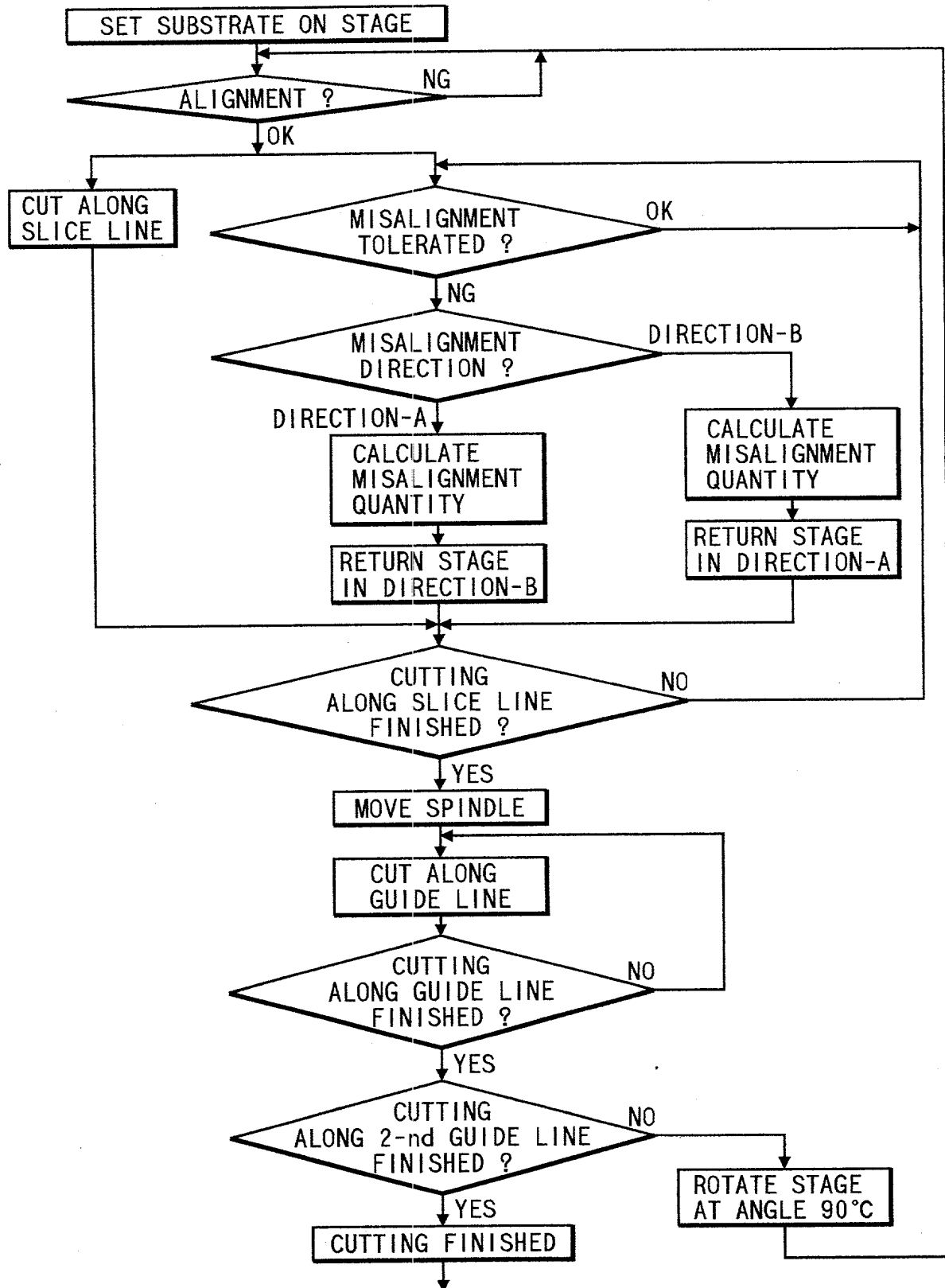
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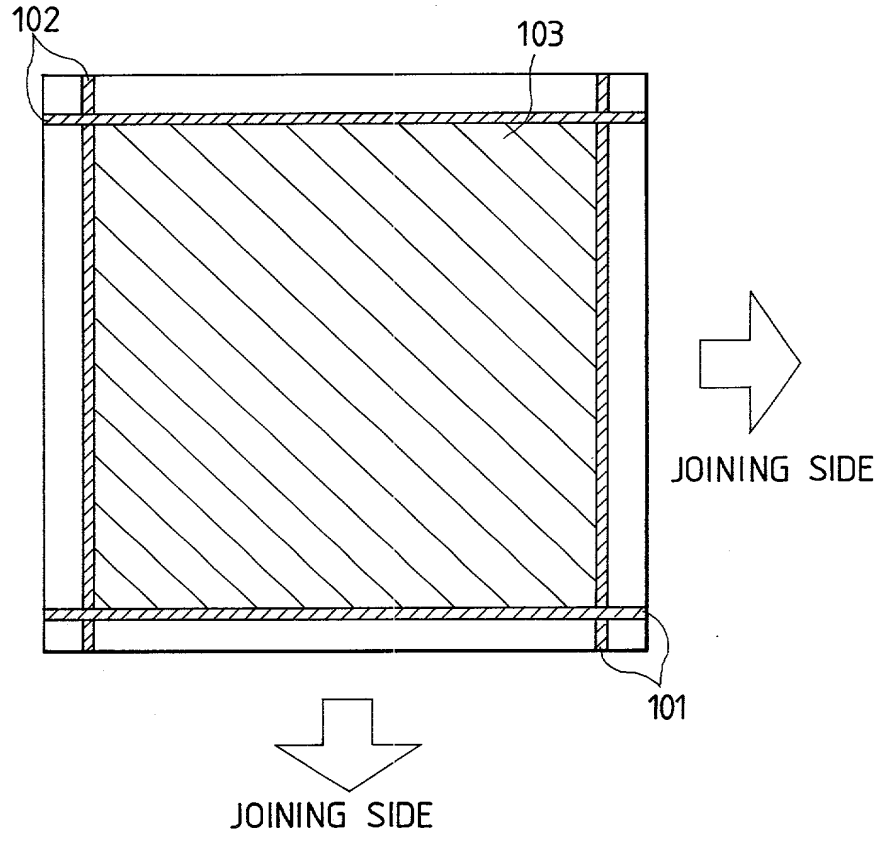
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FIG. 7



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FIG. 8



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FIG. 9A

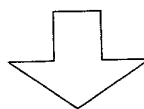
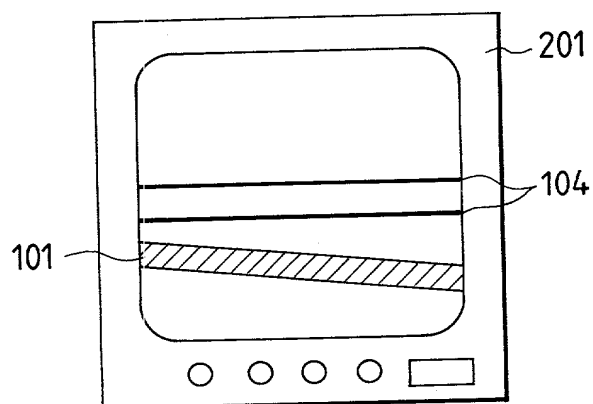
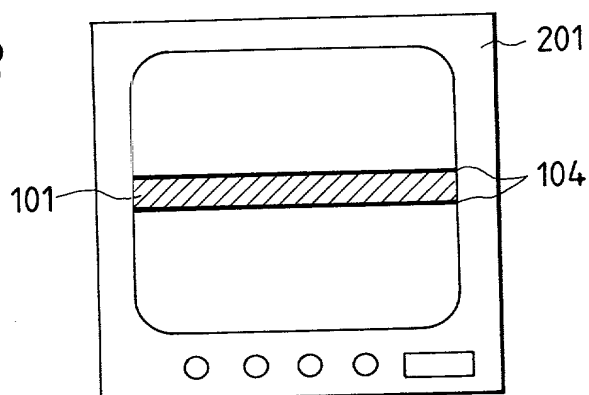


FIG. 9B



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FIG. 10

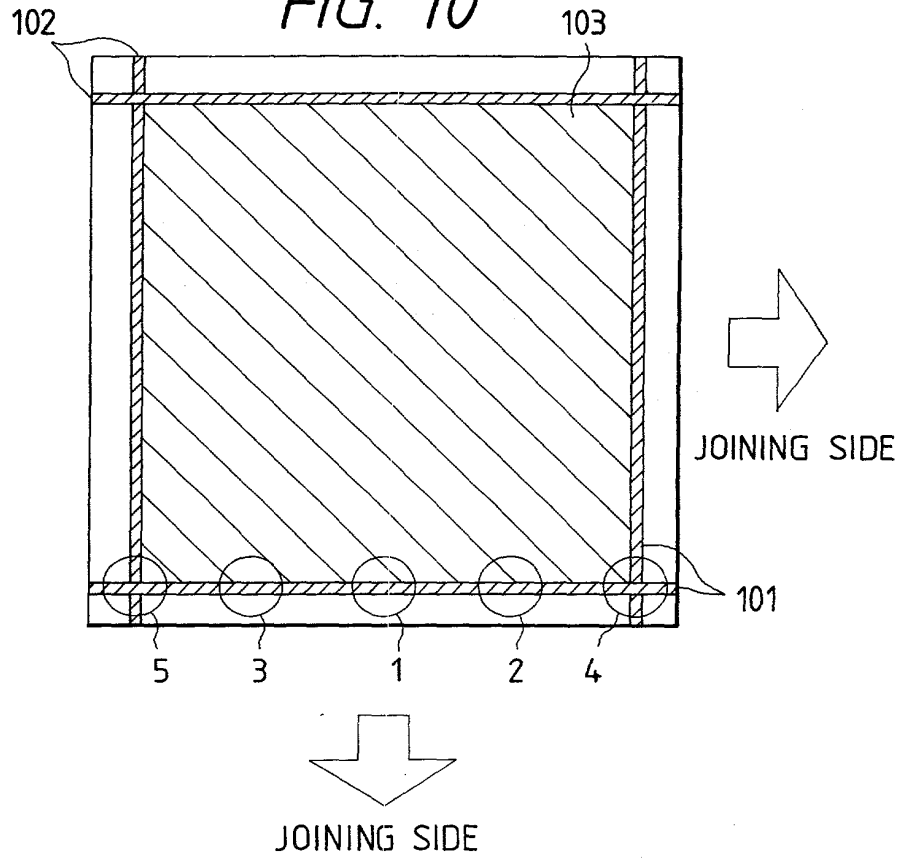
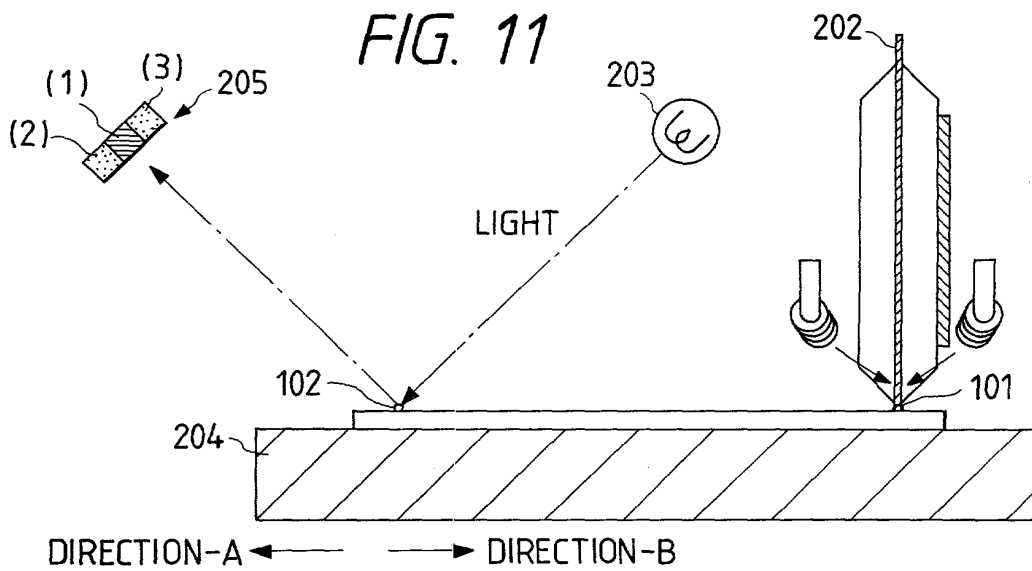


FIG. 11



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FIG. 12A

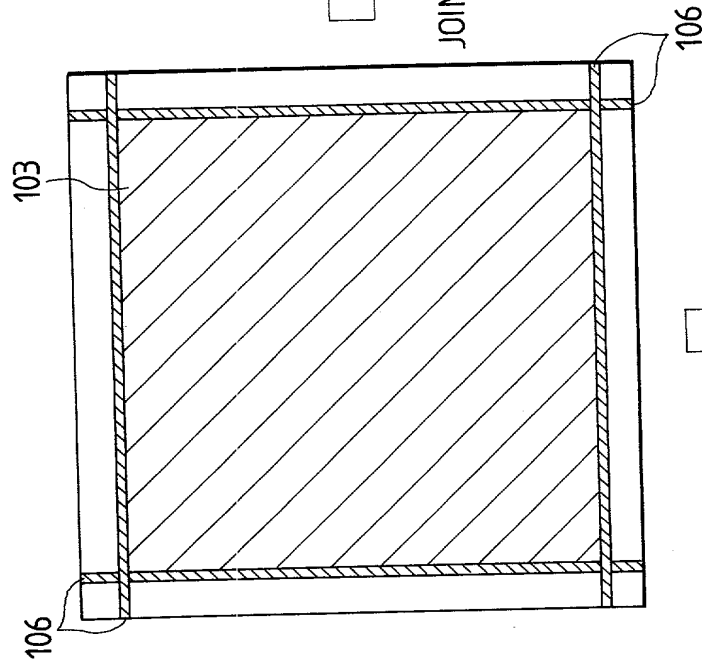


FIG. 12B

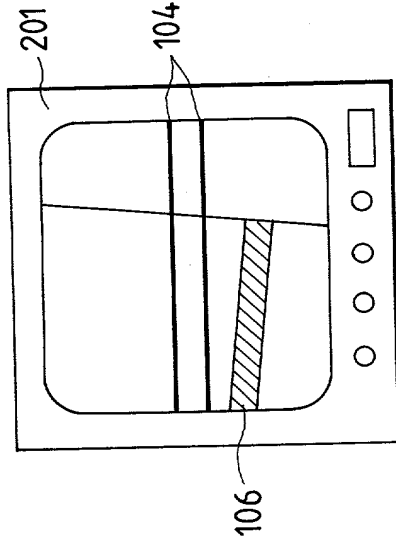


FIG. 12C

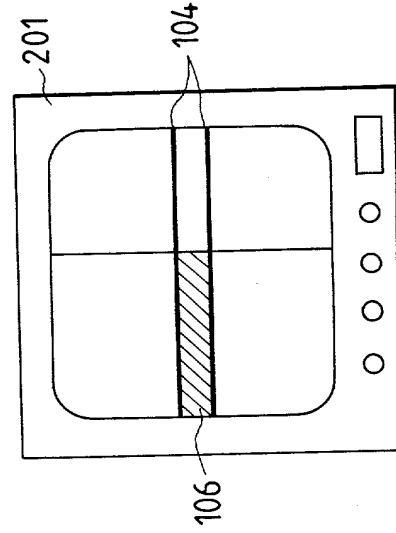


FIG. 13A

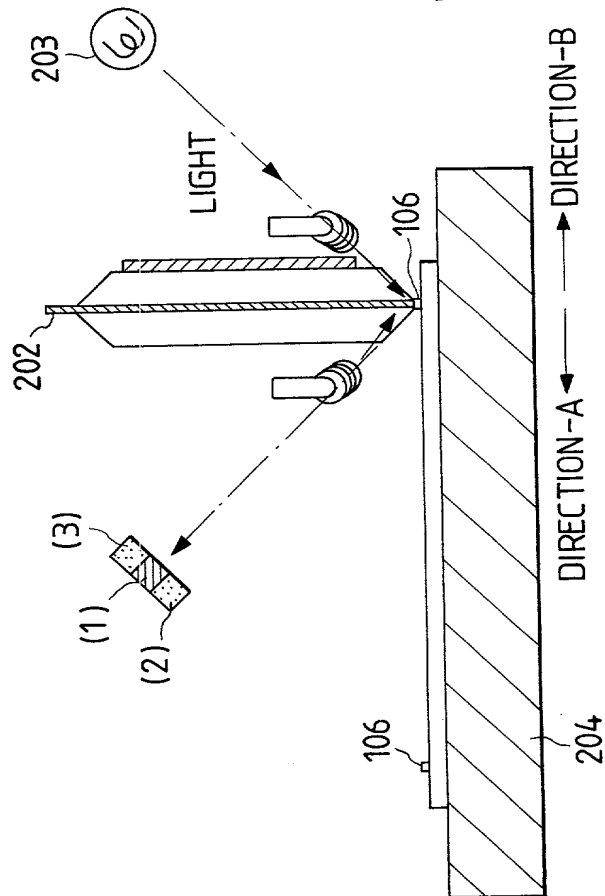
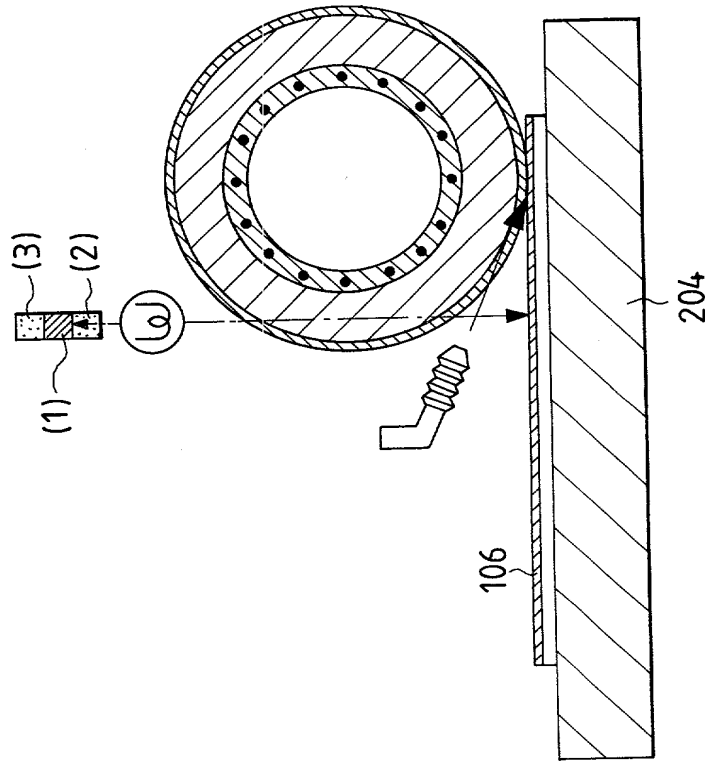
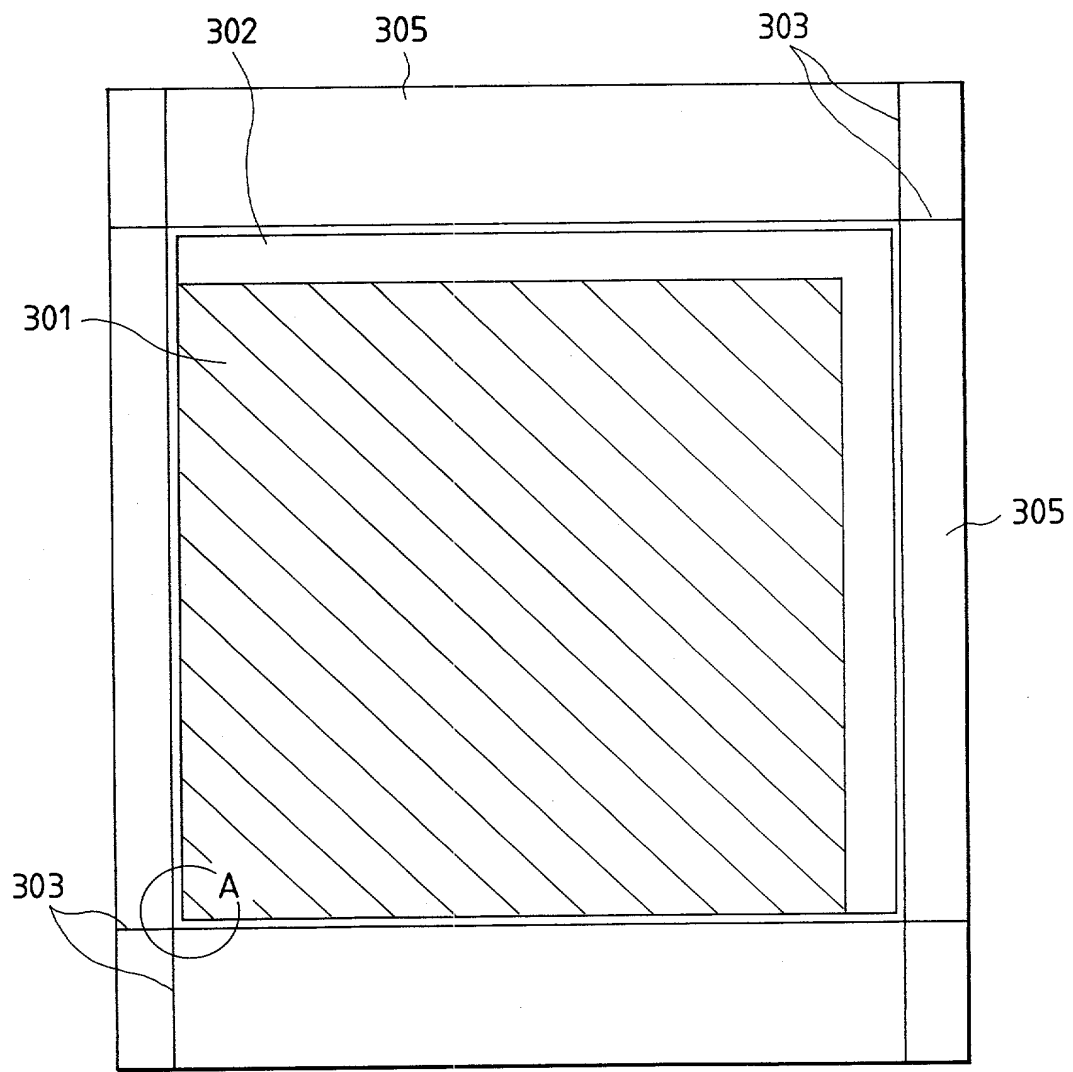


FIG. 13B



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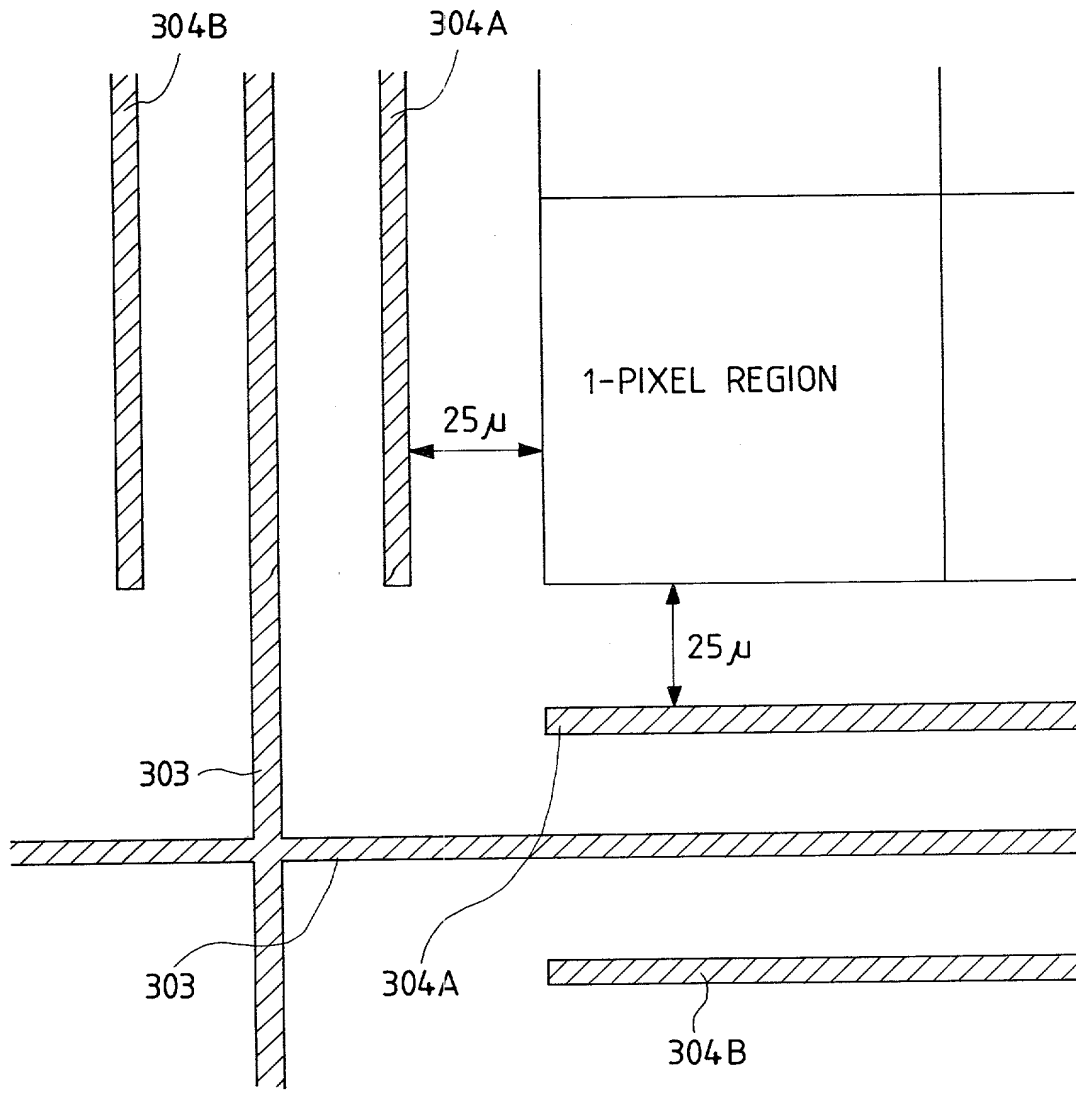
FIG. 14



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FIG. 15

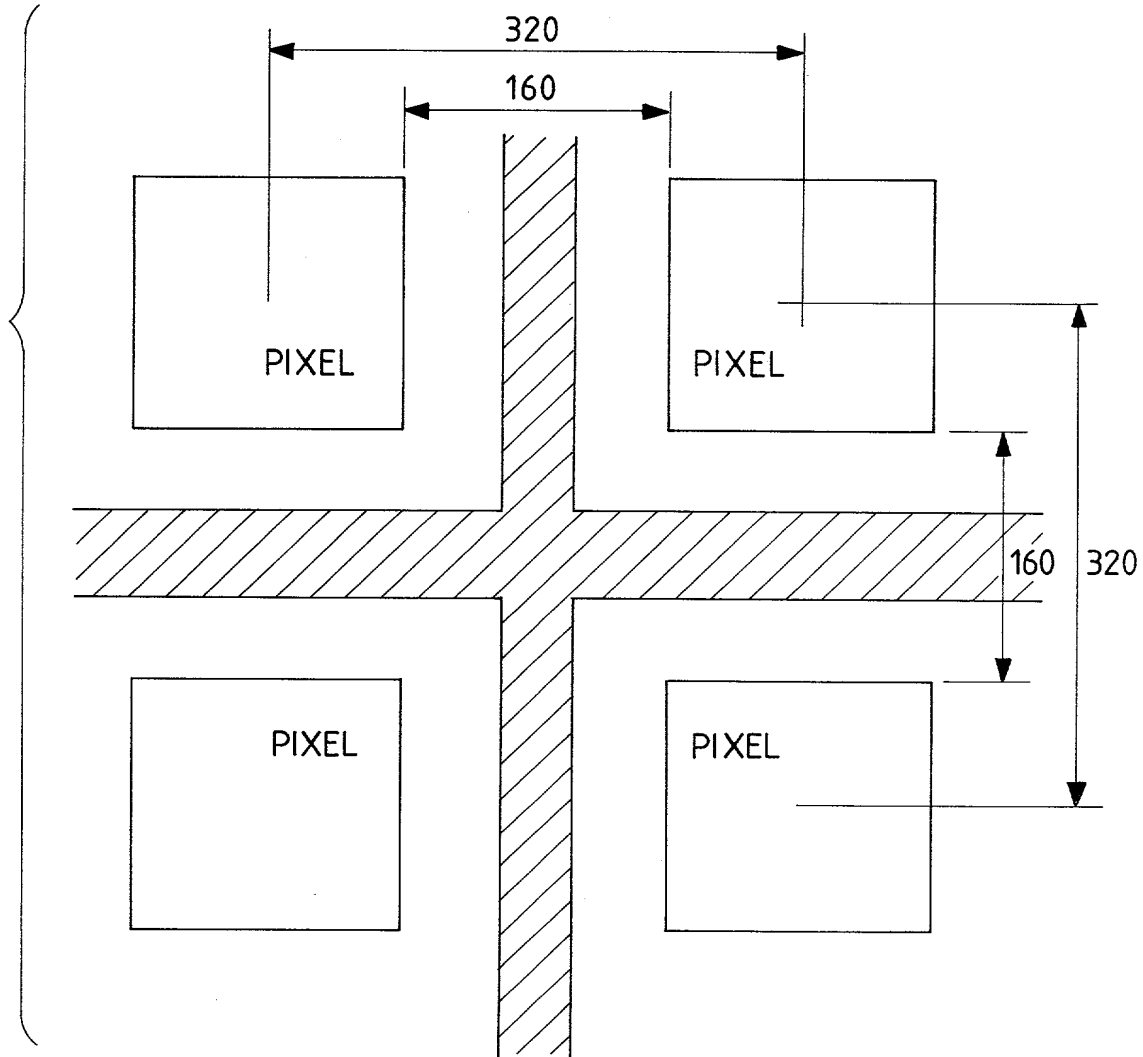




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FIG. 16



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FIG. 16

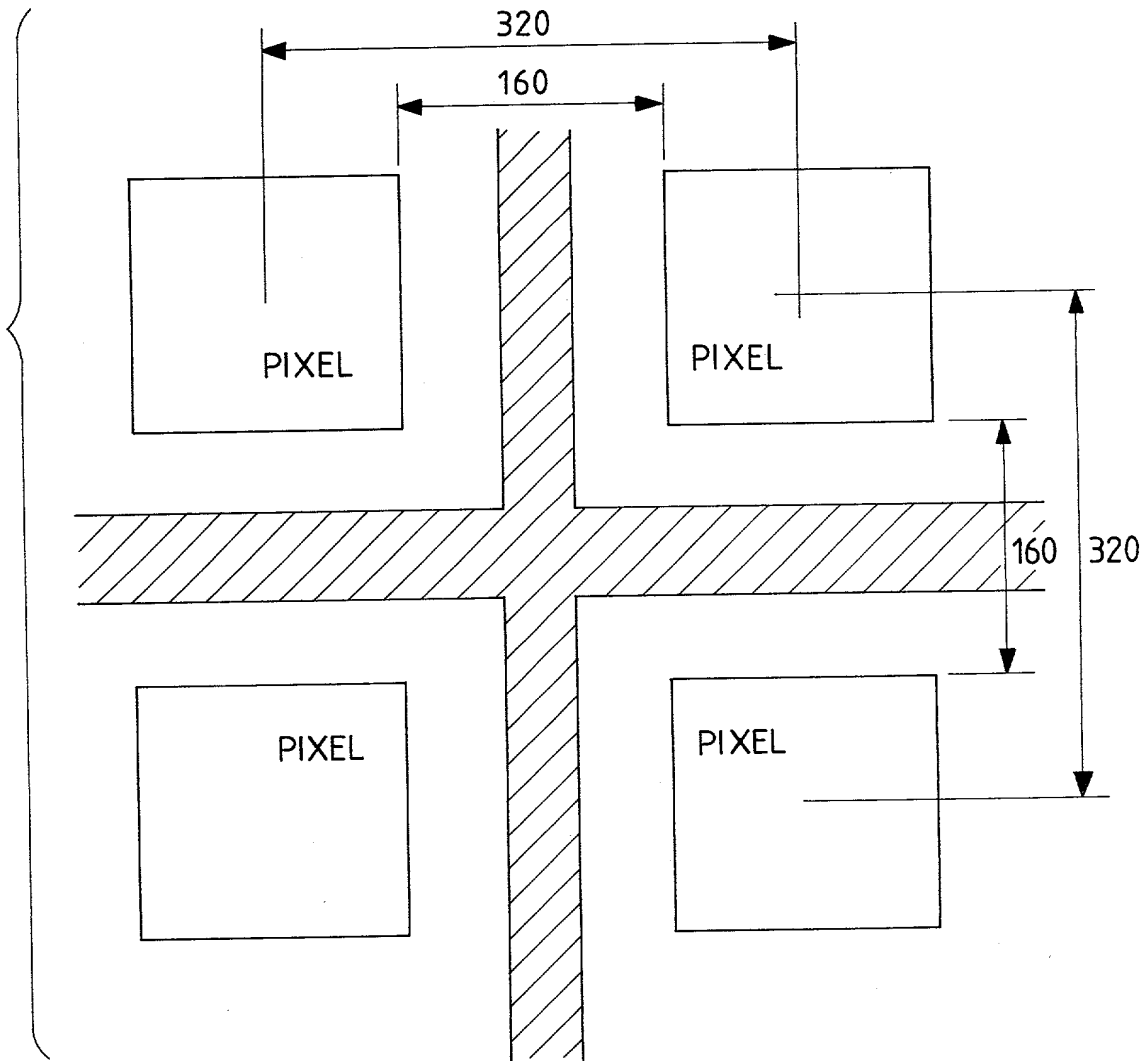


FIG. 17

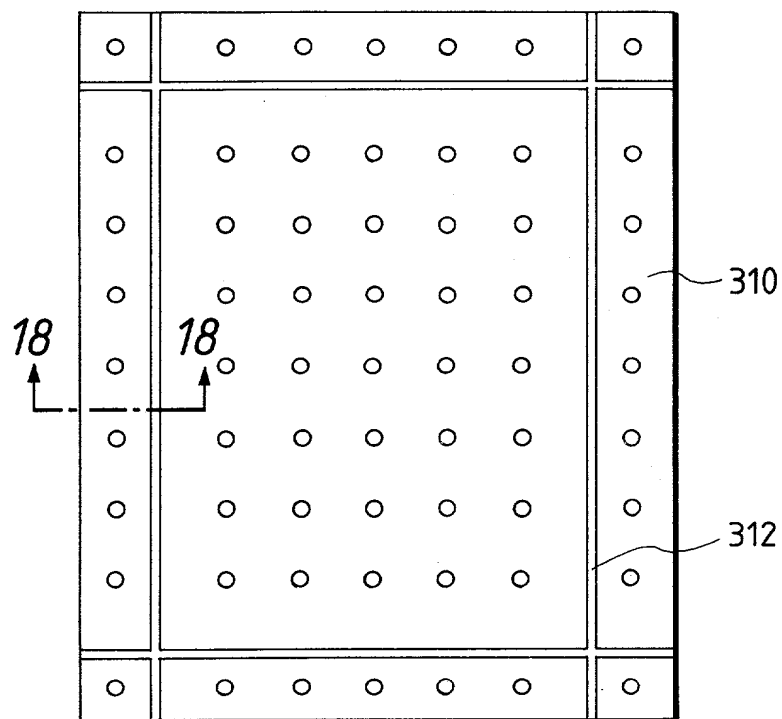
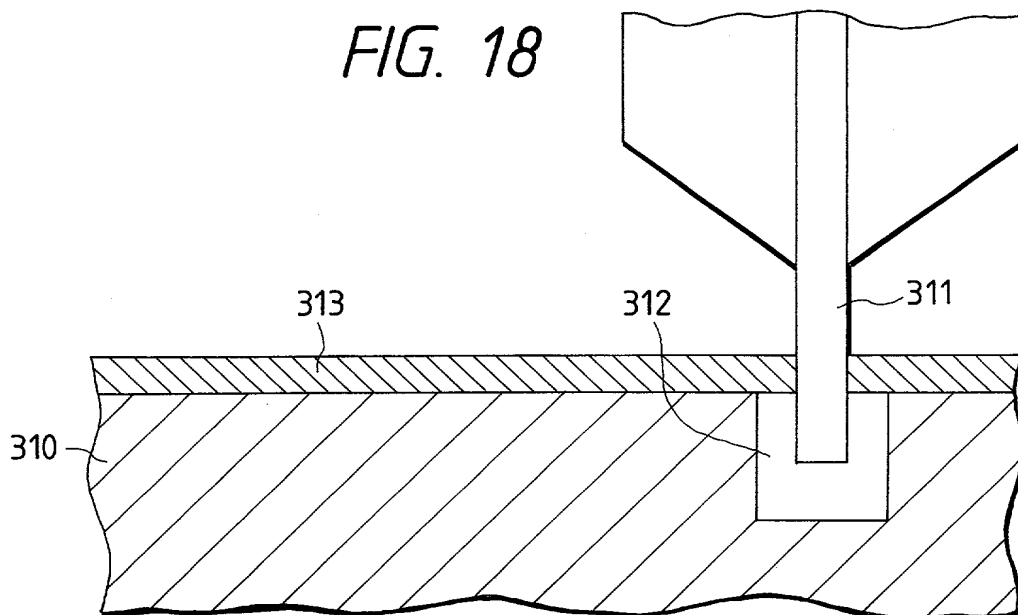


FIG. 18

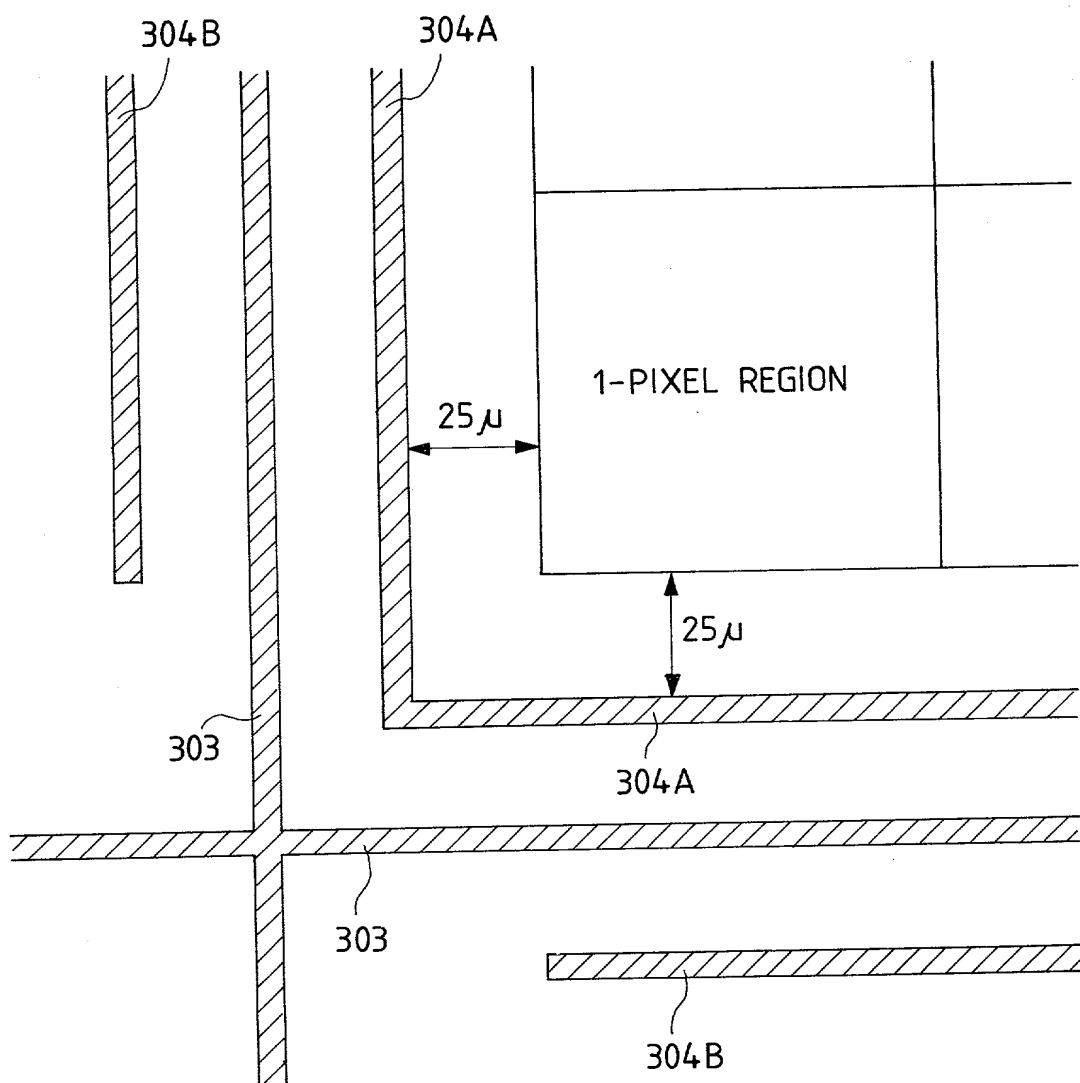


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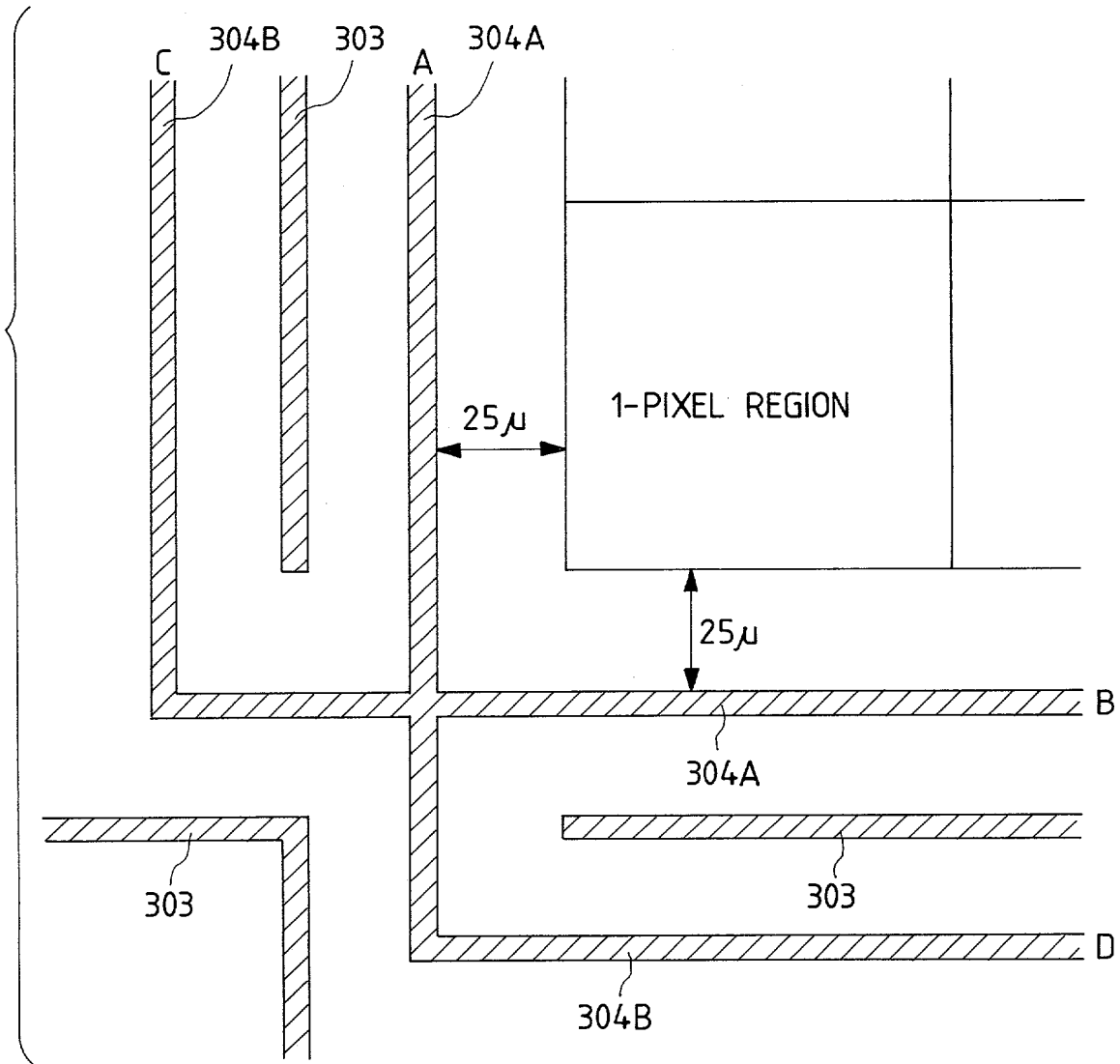
FIG. 19



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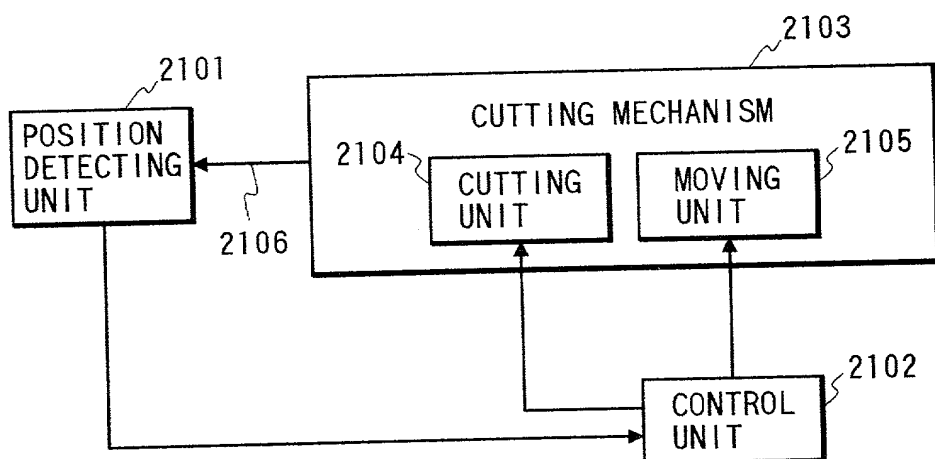
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FIG. 20



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FIG. 21





COMBINED DECLARATION AND POWER OF ATTORNEY  
FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name;

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled SUBSTRATE CUTTING METHOD AND SUBSTRATE CUTTING APPARATUS, the specification of which

☐ is attached hereto. ☒ was filed on February 18, 1997 as Application No. 08/801,464

and was amended \_\_\_\_\_ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Country	Application No.	Filed (Day/Mo./Yr.)	Priority Claimed (Yes/No)
JAPAN	8-033615	21 February 1996	YES
JAPAN	9-027837	12 February 1997	YES

I hereby appoint Joseph M. Fitzpatrick (Registration No. 17,398), Lawrence F. Scinto (Registration No. 18,973), William J. Brunet (Registration No. 20,452), Robert L. Baechtold (Registration No. 20,860), John A. O'Brien (Registration No. 24,367), John A. Krause (Registration No. 24,613), Henry J. Renk (Registration No. 25,499), Peter Saxon (Registration No. 24,947), Anthony M. Zupcic (Registration No. 27,276), Charles P. Baker (Registration No. 26,702), Stevan J. Bosses (Registration No. 22,291), Edward E. Vassallo (Registration No. 29,117), Ronald A. Clayton (Registration No. 26,718), Lawrence A. Stahl (Registration No. 30,110), Laura A. Bauer (Registration No. 29,767), Leonard P. Diana (Registration No. 29,296), David M. Quinlan (Registration No. 26,641), Nicholas N. Kallas (Registration No. 31,530), William M. Wannisky (Registration No. 28,373), Lawrence S. Perry (Registration No. 31,865), Robert H. Fischer (Registration No. 30,051), Christopher Philip Wrist (Registration No. 32,078), Gary M. Jacobs (Registration No. 28,861), Michael K. O'Neill (Registration No. 32,622), Bruce C. Haas (Registration No. 32,734), Scott K. Reed (Registration No. 32,433), Scott D. Malpede (Registration No. 32,533), Fredrick M. Zullo (Registration No. 32,452), Richard P. Bauer (Registration No. 31,588), Warren E. Olsen (Registration No. 27,290), Abigail F. Cousins (Registration No. 29,292), Steven E. Warner (Registration No. 33,326), Thomas J. O'Connell (Registration No. 33,202), Aaron C. Deditch (Registration No. 33,865), Penina Wollman (Registration No. 30,816), David L. Schaeffer (Registration No. 32,716), Jack S. Cubert (Registration No. 24,245), Mark A. Williamson (Registration No. 33,628), John T. Whelan (Registration No. 32,448), Jean K. Dudek (Registration No. 30,938), Raymond R. Mandra (Registration No. 34,382), Dominick A. Conde (Registration No. 33,856), Steven C. Bauman (Registration No. 33,832), Pasquale A. Razzano (Reg. No. 25,512), John W. Behringer (Registration No. 23,086), Robert C. Kline (Registration No. 17,739), Mark J. Itri (Registration No. 36,171), William C. Hwang (Registration No. 36,169), Karin L. Williams (Registration No. 36,721), Michael P. Sandomato (Registration No. 35,345), Jack M. Arnold (Registration No. 25,823), John D. Carlin (Registration No. 37,292), Daniel S. Glueck (Registration No. 37,838), Victor J. Geraci (Registration No. 38,157), Joseph W. Ragusa (Registration No. 38,586), Brian L. Klock (Registration No. 36,570), Anne M. Maher (Registration No. 38,231), William J. Zak, Jr. (Registration No. 38,668), Thomas D. Pease (Registration No. 35,317), Bruce M. Wexler (Registration No. 35,409), and Robert S. Mayer (Registration No. 38,544) my attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

Address all correspondence to:

FITZPATRICK, CELLA, HARPER & SCINTO  
277 Park Avenue  
New York, N.Y. 10172  
Telephone No. (212) 758-2400

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FOR PATENT APPLICATION

(Page 2)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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30-2, Shimomaruko 3-chome, Ohta-ku, Tokyo, Japan

Full Name of Third Joint Inventor, if any \_\_\_\_\_  
Third Inventor's signature \_\_\_\_\_  
Date \_\_\_\_\_ Citizen/Subject of \_\_\_\_\_  
Residence \_\_\_\_\_  
Post Office Address \_\_\_\_\_

Full Name of Fourth Joint Inventor, if any \_\_\_\_\_  
Fourth Inventor's signature \_\_\_\_\_  
Date \_\_\_\_\_ Citizen/Subject of \_\_\_\_\_  
Residence \_\_\_\_\_  
Post Office Address \_\_\_\_\_

Full Name of Fifth Joint Inventor, if any \_\_\_\_\_  
Fifth Inventor's signature \_\_\_\_\_  
Date \_\_\_\_\_ Citizen/Subject of \_\_\_\_\_  
Residence \_\_\_\_\_  
Post Office Address \_\_\_\_\_